And the Human Saves the Day or Maybe They Ruin It, The Importance of Humans in the Loop

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Scope

Discuss the concepts of:

- Human involvement in technological programs
- How a Probabilistic Risk Assessment (PRA) accounts for the human in the loop for potential missions
- Using a technique called Human Reliability Analysis (HRA) to asses human risk for a PRA
- Tradeoffs between having a human in the loop or not

Introduction

- PRA identifies potential risk contributors
- HRA is part of the PRA capturing human interactions and predicts impact on overall mission risk
- Not all human errors have serious consequences
- Human actions can increase or decrease the overall risk; removing the human from the loop doesn’t always lower the risk

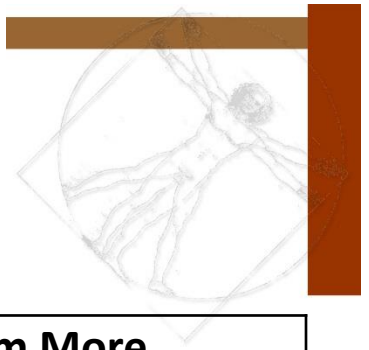
Removing the Human from the Equation May Result In

- Unnecessary Loss of Mission (LOM) because the automated system is too rigid
- No crew to intervene for potential vehicle separation issues
- No changes to software when needed (humans are involved with developing software codes, and uploading code to the spacecraft)
- Loss of flexibility and capability for the overall system since humans can backup multiple systems and perform multiple functions
- Automated systems cannot address potential situations that have not been identified but could escalate into failure events

Automated Flight Controls with Humans as Backup

Inherent risks using humans in the loop	Inherent risks of not using humans in the loop
Cause a failure (errors of omission / commission)	Lose flexible backup
Not react in time (slips/lapses, mistakes, and circumventions)	Lose limited maintenance capability for minor repairs
Misinterpret or misunderstand (information processing errors such as detection and situation assessment)	Lose oversight and minor problems dealt with as they arise
Right action, wrong time (skill-, rule-, knowledge-based errors or information processing)	Failure is failure, software doesn't adapt unless in the programming
Bad decisions cause failures (skill-, rule-, knowledge-based errors, information processing)	Does not react to any visual or physical "cues" not in the programing
Bad decisions contribute to failure (skill-, rule-, knowledge-based errors, information processing)	Does not address unexpected consequences of programed actions
	Loss of communication with software means loss of update capability
	Cannot distinguish between "bad" data and "good"

Human Direction versus Automation



Human More Effective/Efficient	Automated System More Effective/Efficient
When nothing goes as planned or expected	Everything goes as planned or expected
No set routine, needs flexible response	Set routine with limited deviation
Deal with unexpected consequences	Capabilities all identified
Need flexibility in actions for response	Consistent, repetitive actions and activities
Additional capabilities needed beyond original expectations	Immediate response to event needed (too fast for human actions)
Repair small problems to avoid them becoming large problems	Barring software or system failures, always performs as programmed
By adapting to the situation, people often provide the flexibility to "make it work"	Complex or complicated actions needing quick response
Human can be used to mitigate failures	Performs for long durations
When considering outside information and context in decision making, "it depends on…"	When there are no "maybes" in the decision process
Threat detection using multiple subtle cues	Quick response actions for set-points /limits

NOTES:

- Automated systems can only follow their programming
- Programming is done by humans based on what they expect to happen
- Changes to programming (updates) are developed and input by humans

Human Interactions Can Be Good or Bad

The Good:

While HRA assumes that humans fail a percentage of the time, sensitivity studies show what would occur if a crew was not available to make the attempt.

- Orion ~33 % of overall risk was reduced when the crew could perform manual aborts
- Shuttle crew and mission control active response to failures showed a risk reduction of ~91%.

The Bad:

- The human body undergoes physical changes that affect their capabilities to react appropriately
- Situations can overwhelm humans regardless even with the best planning and training
- Humans can take direct action to save the vehicle, those actions taken at the wrong time or under the wrong conditions can also result in loss of the vehicle

Summary

- On a really bad day when nothing is going as expected, an automated system gives up, but a human will keep trying and may succeed.

- Spaceflight is a risk, with or without human error.